The Economics of the IPCC's Special Report on Limiting Temperatures to 1.5 °C

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The Intergovernmental Panel on Climate Change (IPCC) published a special report (hereafter called SR15) on the impacts of global warming of 1.5 °C above pre-industrial levels on October 8, 2018. The report says the cost of mitigating CO_2 emissions in 2030 to prevent temperatures from exceeding 1.5 °C above pre-industrial levels is about 880 $US\$_{2010}$ per tonne of CO_2 ($\$/tCO_2$). The benefit of doing so, according to the report, is 15 $\$/tCO_2$. Using a climate sensitivity based on observations including effects of natural climate change, urban warming and the best available economic model, the mitigation proposal will prevent a benefit of 8.2 $\$/t\ CO_2$, for a total loss of 888 $\$/tCO_2$ mitigated. In other words, each $1000 spent on mitigation of CO_2 emissions will cause another loss $9.20.

The SR15, presents various emissions pathways to limit the projected rise of temperatures from pre-industrial times, estimated to be the temperature average from 1850 to 1900, to the year 2100, and to limit the temperature rise to 2.0 °C by 2100. According to the IPCC, temperatures have increased by about 1.0 °C from pre-industrial times to 2017. Therefore, the emissions pathways to limit warming allows only 0.5 °C temperature rise from 2017, assuming there is no natural caused climate change.

Three sets of emission pathways to limit warming to 0.5 °C from 2017 to 2100 were presented; with no overshoot, allowing a 0.1 °C temperature overshoot before 2100 and allowing a 0.1 °C to 0.4 °C temperature overshoot. In all cases, temperatures are not allowed to rise after 2100.

The SR15 provides estimates of the marginal cost of mitigation policies to reduce emissions that are consistent with the emissions reduction pathways, which is called the "price of carbon". The marginal cost of reducing an extra tonne of CO_2 emissions is also the effective carbon tax required to meet the emissions reduction target. The effective carbon tax is the carbon tax level that alone would meet the emissions reduction target assuming there are no other policies or regulations imposed to discourage fossil fuel use. That is, no fuel economy standards, no cap and trade, no subsidies or tax breaks to renewable energy projects, and no mandates on electricity providers to use renewable energy. In reality, carbon taxes and regulations designed to reduce emissions are always imposed together, so carbon taxes should be far less than effective carbon taxes proposed in SR15 even if a temperature limit target is deemed to be desirable.

The "price of carbon" discussed in SR15 must not be confused with the "social cost of carbon". The SR15 glossary defines the carbon price;

"The price for avoided or released carbon dioxide (CO2) or CO2-equivalent emissions. This may refer to the rate of a carbon tax, or the price of emission permits. In many models that are used to assess the economic costs of mitigation, carbon prices are used as a proxy to represent the level of effort in mitigation policies."

Chapter 2, section 2.5.2.1, 1st paragraph says, "The price of carbon assessed here is fundamentally different from the concepts of optimal carbon price in a cost-benefit analysis, or the social cost of carbon …prices for carbon (**mitigation costs**) reflect the stringency of mitigation requirements at the margin (i.e., cost of **mitigating** one extra unit of emission)." [bold emphasis added]

The SR15 [Chapter 2, page 78, section 2.5.2.1, 2nd paragraph] says the price of carbon in 2030 required to meet the 1.5 °C target above the 1850-1900 average temperature with no temperature overshoot is estimated in the range of 135 to 5500 $/tCO_2$. Figure 2.26, top panel on page 80 shows that the median estimate is ~880 $/tCO_2$, which is reproduced here as Figure 1. (Look carefully to see the black line on the dark blue and the logarithmic grid-lines.)

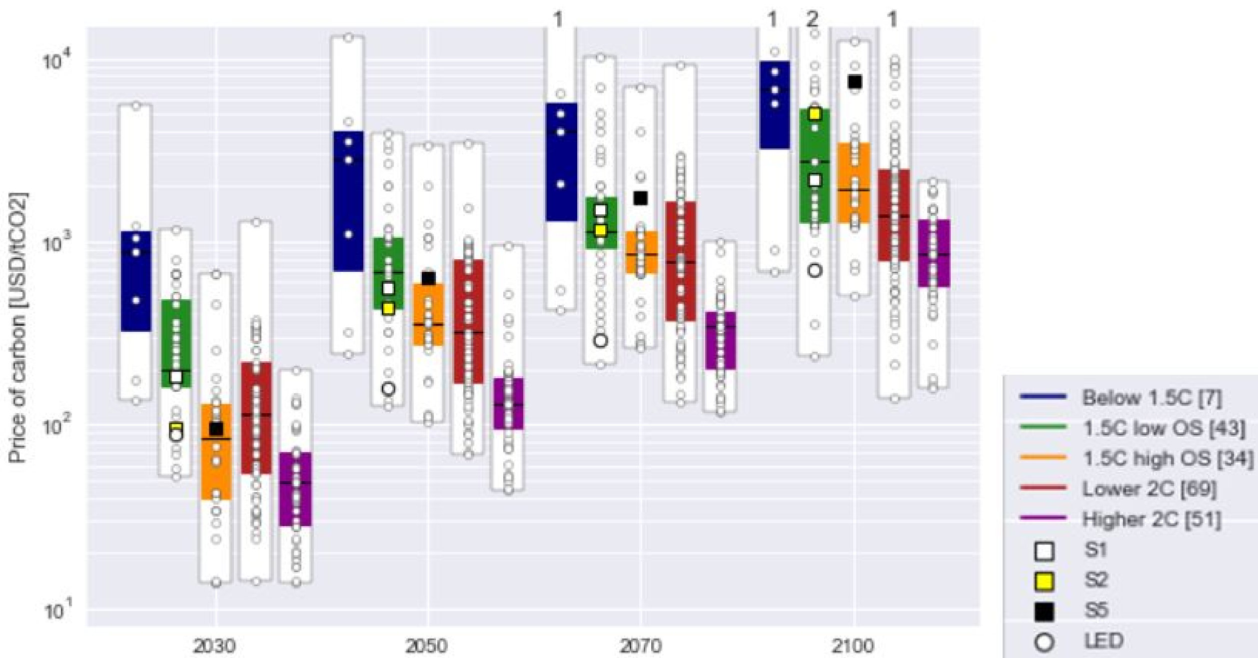

Figure 1. Copy of figure 2.26 top panel of SR15. Global price of carbon emissions consistent with mitigation pathways showing the undiscounted price of carbon (2030-2100). Median values in floating black line. The coloured bars are the interquartile estimates.

Figure 1 shows that allowing temperatures to temporarily rise 0.1 °C above the 1.5 °C target before 2100 would reduce the 2030 effective carbon tax from 880 to 200 $/tCO_2$ (the green bar), and allowing temperatures to temporarily rise between 0.1 to 0.4 °C above the 1.5 °C target before 2100 would reduce the 2030 effective carbon price to 83 $/tCO2 (the orange bar). The sea levels would be 10 cm lower in 2100 at the 1.5 °C target than at the 2 °C target [Chapter 3, page 8]. That is a tiny difference. If temperatures were limited to the 2 °C target during the entire 21st century with a 50% to 66% likelihood (the purple bar), the required effective carbon tax falls to $40 $/tCO2 in 2030. These are all the median estimates. Even if one believed a temperature limit is desirable, a 2 °C target is far better than a 1.5 °C target.

The SR15 did not recommend that the world should meet the target temperature of 1.5 °C, nor does it recommend a particular effective carbon tax rate. That would require a cost-benefit analysis, which is absent from the report.

So, what is the benefit of reducing emissions? That is calculated as the Social Cost of Carbon (SCC), which is actually the social costs less benefits of CO_2 emissions. The SCC is calculated by so-called Integrated Assessment Models (IAMs) which attempt to model the economic and social impacts of increasing CO_2 in the atmosphere. Some IAMs include some limited benefits of CO_2 emissions, including CO_2 fertilization of plants and crops and the benefits of warming temperatures. Many benefits of warming are not included in any IAM.

The SR15 says the SCC is \$15/tCO_2 (without speculative tipping points) from the DICE IAM [Chapter 3, Box 3.6, page 153]. SR15 assumes a 5% discount rate (DR), as per last paragraph page 2-78 and caption of figure 2.26.

“The social cost of carbon in the default setting of the Dynamic Integrated Climate-Economy (DICE) model … [is] \$15/tCO_2“.

The Dayaratna, McKitrick and Kreutzer (DMK2017) paper "Empirically Constrained Climate Sensitivity and the Social Cost of Carbon Dioxide" shows the DICE IAM gives a SCC of \$15.33 in 2030 at 5% DR [table 2] , in agreement with Box 3.6 of SR15. The paper also shows that the FUND IAM calculates the SCC in 2030 at 5% DR is 3.31 \$/tCO_2 [table 4]. This value is from the FUND model as modified by the US government’s Interagency Working Group on the Social Cost of Carbon. It gives a higher SCC than the default parameters of the FUND model assigned by the model’s developers. The average of these two estimates is 9.32 \$/tCO_2, being the social cost of CO_2 emissions or the benefit of the emissions reduction in 2030. Both of these estimates use an equilibrium climate sensitivity (ECS) probability distribution based on climate modeling simulations from Roe and Baker (2007) that has a 90% range of 1.72 – 7.14 °C with a median of 3.0 °C and a mean of 3.5 °C. ECS is the global temperature change due to a doubling of the CO_2 air concentration after allowing the oceans to reach temperature equilibrium, which takes around 2500 years in the models.

SR15 says the cost to reduce emissions to meet the 1.5 °C target with no temporary overshoot requires an effective carbon tax (with no other emission reduction policies) in 2030 of about 880 \$/tCO_2. The benefit of this emissions reduction is 15 \$/tCO_2 according to SR15 from the DICE model. If this is an appropriate comparison, the SR15 implies that the cost is about 60 times the benefit. If the SR15 had used the average SCC from the DICE and FUND models of 9.32 \$/tCO_2 the cost of emissions reduction would be about 94 times the benefit.

The SR15 climate sensitivity is not based on empirical estimates. The DMK2017 paper shows that using the Lewis and Curry 2015 (L&C2015) energy balance, observation-based climate sensitivity distribution, the 2030 SCC from DICE and FUND drops to 8.67 and -0.19 \$/tCO2, respectively, giving an average 4.24 \$/tCO_2. The cost of the emissions reduction in 2030 is about 208 times the benefit using the DMK2017 SCC values assuming the L&C2015 climate sensitivity distribution with an ECS best estimate of 1.64 °C.

The L&C2015 ECS estimate however, is very likely too high as it fails to account for natural climate change and the contamination of the global temperature record by the urban heat island (UHI) effect, poor surface station siting and bad temperature adjustments. It is curious that Dr. Ross McKitrick, being one of the authors of the DMK2017 paper, did not account for the natural temperature recovery from the Little Ice Age, as he with Steven McIntyre restored nature climate change to history by showing that the Dr. Michael Mann hockey stick graph that was so prominent in the IPCC's third assessment report was seriously flawed. McKitrick with Dr. Pat Michaels also showed that the temperature record was highly correlated with indicators of economic development indicating that the record is contaminated by the UHI effect.

Adjusting the L&C2015 estimate of ECS to account for the natural recovery from the Little Ice Age, a recent aerosol forcing estimate and the UHI effect from 1980 reduces the best estimate to only 1.0 °C as shown here. Dr. Ray Bates published a paper using a 2-zone energy balance model that also determined a best estimate of the ECS of 1.0 °C.

An analysis of the DICE IAM by Dr. Patrick Michael show that the DICE model grossly overestimates sea level rise compared to IPCC estimates, and contains only insignificant benefits of CO_2 fertilization. The new Julia version of the FUND model, which does include at least significant CO_2 fertilization benefits, using the reasonable 1.0 °C estimate of ECS gives a SCC at 2030, 3% DR of -8.2 $/tCO2 as shown here. The negative sign indicates that CO_2 emissions are globally net beneficial. Figure 2 summarizes the cost of emissions reduction to meet the 1.5 °C target compared to three estimates of the benefit of those reductions.

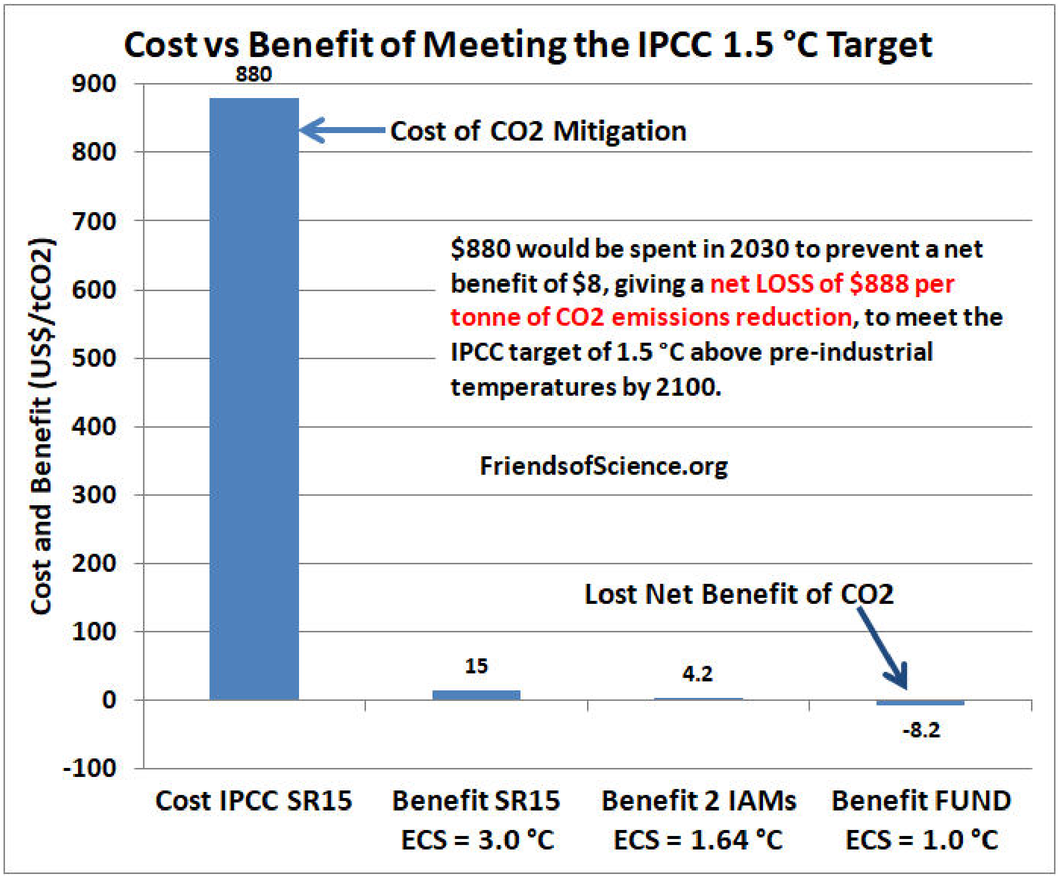

Figure 2. Summarizes the cost of mitigation to limit global warming due to greenhouse gas emissions to 1.5 °C about pre-industrial temperatures, and three estimates of the benefits of those efforts in terms of the social cost of carbon. The Cost is the median of the range of estimates as shown in Figure 1. The "Benefit SR15" is the benefit of emissions reduction reported in SR15 from the DICE IAM. The "Benefit 2 IAMs" is the benefit as reported by DMK2017 using the DICE and FUND IAMs and the ECS from L&C2015. The "Benefit FUND" is the benefit of emissions reduction from the new Julia version of FUND using the median ECS estimate of ECS L&C2015 adjusted for natural climate change, UHI effects and new aerosol forcing estimates.

Effective carbon taxes would increase substantially from 2030 to 2100 to meet a temperature target limit. However, the FUND model predicts that the world income per capita will increase by a factor of 2.8 from 2030 to 2100 in constant dollars despite projected impacts from global warming at an ECS of 3 °C. Carbon taxes and other mitigation polices transfers wealth from us relatively poor people today to the extremely wealthy people of the future.

Predictably, the news media has misrepresented the report, claiming that the SR15 says the world must impose a huge tax on CO_2 emissions to prevent catastrophic climate change. The New York Times said "The United Nations report estimated that governments would need to impose effective carbon prices of $135 to $5500 per ton of carbon dioxide pollution by 2030 to keep overall global warming below 1.5 degrees Celsius … nations will have to do far more than they are currently doing for the world to have hope of avoiding drastic climate change."

A Bloomberg article headline says, "How High Does Carbon Need to Be? Somewhere From $20-$27,000". The article says, "prices may need to jump above $1,000 sometime before 2030 and perhaps reach as much as $27,000 by the end of the century." The 1000 $/t$CO_2$ refers to the top of the blue interquartile range of Figure 1 for 2030. The 27,000 $/t$CO_2$ refers to the extreme highest estimate of the most extreme scenario that could meet the 1.5 °C target in 2100, which may imply little mitigation in the early part of the century and very burdensome mitigation by the latter part of the century. Why not report the range of 690–27000 $/t$CO_2$, or the median value of $6,800/t$CO_2$ in the year 2100, rather than just report the most extreme estimate?

The news media reported only the cost of mitigation CO_2 emission, which is the cost of solar and wind farms, costs of carbon taxes and regulations to meet an arbitrary target. They fail to compare this cost to possible benefits. Nor do they recognize that the IPCC is a political body, not a scientific one. It has falsely attributed natural global warming to greenhouse gas anthropogenic global warming.